CLAIMS

1. A method of producing a shaped charged particle beam, comprising:

emitting charged particles from a charged particle source;

forming a charged particle beam from the emitted charged particles;

passing the charged particle beam through an aperture having a geometric shape with at least one straight edge; and

focusing the charged particle beam from the source onto a focal plane away from a target plane to produce at the target plane a beam, wherein said aperture is dimensioned to produce a beam shape at the target having at least one sharp edge and a high current value.

2. The method of claim 1 in which the aperture has a rectangular shape and comprises a major side positioned near the center of the beam thereby forming a charged particle beam having at the target plane a sharp edge with high resolution that is substantially unaffected by chromatic and spherical aberration.

3. The method of claim 2 in which the rectangular aperture has a minor side dimension sufficiently small to produce a beam image at the target with a suitably small tail for a slice and view milling application.

4. The method of claim 1, further comprising employing a line source in a microbeam plasma source for emitting the charged particles, whereby beam current is increased.

5. The method of claim 1, in which the aperture is positioned and dimensioned to have a maximum beam current density at the at least one sharp edge with said current density rolling off to an opposite side of the aperture away from the sharp edge in accordance with a particular milling application.

6. A FIB system, comprising:

a vacuum system;

a charged particle beam column positioned in the vacuum system for creating a charged particle beam for impinging upon a target, the charged particle beam column including one or more lenses and an aperture having at least one straight edge and being disposed within the column and dimensioned to produce a shaped charged particle beam at the target, said shaped beam having at least one sharp edge corresponding to the at least one aperture straight edge;

a secondary electron or charged particle detection and imaging system; and

a controller for controlling the shaped charged particle beam to irradiate an area on the target to mill material away from or add material to the target.

7. The system of claim 6 in which the aperture is aligned with the one or more lenses to under or over focus the charged particle beam source with respect to the target plane.

8. The system of claim 7, in which the aperture is rectangular shaped and comprises a major side corresponding to the at least one straight edge disposed near the center of the beam.

9. The system of claim 8 in which the rectangular aperture has a minor side dimension that is sufficiently small to produce a beam image at the target with a suitably small tail for a slice and view milling application.

10. The system of claim 6, wherein the charged particle column comprises a line source in a microbeam plasma source for increasing beam current.

11. The method of claim 6, in which the aperture is positioned and dimensioned in the charged particle beam column to have a maximum beam current density at the at least one

sharp edge with said current density rolling off toward an opposite side of the aperture away from the sharp edge in accordance with a particular milling application.

12. The system of claim 11, wherein the beam is chromatic limited and wherein the target is defocused relative to a first order focal plane in accordance with: $|Z_0| \geq C_C\, dE_0/E_0$ where C_C is the chromatic aberration coefficient and dE/E_0 is the charged particle energy spread divided by the average charged particle energy.

13. The system of claim 6, wherein the charged particle column further comprises a stigmator to adjust the beam shape in order to rotate the at least one sharp edge in alignment with an axis on the target.

14. The system of claim 6, wherein said aperture is D-shaped, and the target is de-focused away from a first order focal plane a distance $Z_0 \geq C_S\, A_0^2$ where C_s is the spherical aberration coefficient and A_o is the maximum beam angle with respect to the optical axis for beams passing through the aperture.

15. A method of producing a shaped charged particle beam, comprising:

emitting charged particles from a charged particle source;

forming a charged particle beam from the emitted charged particles;

passing the charged particle beam through an aperture having a geometric shape with at least one substantially straight edge, said aperture being dimensioned to inhibit beam components with sufficiently large angles according to predefined criteria;

focusing the charged particle beam with respect to the source onto a focal plane away from a target plane to produce at the target plane a de-focused beam image having a shape corresponding to the geometric shape, the beam having significant spherical aberration; and

tuning the beam with a combination of under-focus and stigmation to compensate for said spherical aberration to produce the geometric beam shape at the target, said beam shape having at least one sharp edge corresponding to the at least one straight edge and a high current density value.

16. The method of claim 15, wherein said aperture is offset from an optical beam axis.

17. The method of claim 16, wherein said at least one aperture straight edge is substantially aligned with said optical beam axis.

18. The method of claim 15, wherein the geometric shape is rectangular.

19. The method of claim 15, wherein said geometric shape is elliptical or semi-elliptical.

20. The method of claim 15, further comprising under-focusing the beam by disposing the target away from the first order focal plane by a defocus value Z_o such that $Z_0 \geq C_S A_0^2$ where C_S is the spherical aberration coefficient.